RESEARCH REPORT

1958-1961

Experimental Farm
LACOMBE, ALBERTA

ESEARCH BRANCH - CANADA DEPARTMENT OF AGRICULTURE

Research Report

1958-1961

Experimental Farm

Lacombe, Alberta

RESEARCH BRANCH
CANADA DEPARTMENT OF AGRICULTURE

65002-8—1

ROGER DUHAMEL, F.R.S.C.
QUEEN'S PRINTER AND CONTROLLER OF STATIONERY
OTTAWA, 1963

Cat. No. A56-353/1961

35C—30010—4:63

PROFESSIONAL STAFF

J. G. STOTHART, D.S.O., B.S.A., M.Sc. (McGill)	Superintendent

Livestock

H. T. FREDEEN, B.S.A. (Saskatchewan), M.Sc. (Alberta), Ph.D. (Iowa)	Head of Section Animal breeding
G. H. BOWMAN, B.S.A. (Saskatchewan), M.Sc. (Alberta), Ph.D. (Okla. State)	Animal breeding, carcass studies
H. DOORNENBAL, B.S.A., M.S.A. (U.B.C.), Ph.D. (Cornell)	Physiology
J. A NEWMAN, B.Sc. (Alberta), Dip. An. Gen., Ph.D. (Edinburgh)	Animal breeding

Plant Breeding

A. D. MCFADDEN, B.Sc. (Alberta), M.Sc. (Minnesota)	Head of Section Plant breeding
H. T. ALLEN, B.Sc., M.Sc. (Alberta)	Horticulture
L. J. ANDERSON, B.S.A. (Saskatchewan)	Plant adaptation
H. BAENZIGER, D.I.A. (Zurich), M.Sc., Ph.D. (Saskatchewan)	Forage crops
M. L. KAUFMANN, B.S.A., M.Sc. (Saskatchewan), Ph.D. (Wisconsin)	Cereal crops

Crop Management and Soils

H. A. FRIESEN, B.S.A., M.Sc. (Saskatchewan)	Head of Section
S. R. CHURCH, B.Sc. (Alberta)	Soil fertility
D. A. DEW, B.E. (Saskatchewan)	Tillage and soil physics
W. J. DORAN,[1] B.Sc. (Alberta)	Pasture research
D. R. WALKER, B.Sc., M.Sc. (Alberta)	Soil chemistry

Soil Research Substation, Vegreville

R. R. CAIRNS, B.S.A. (Toronto), M.Sc. (McGill), Ph.D. (Pa. State)	Officer in Charge Soil physics and chemistry

[1] Resigned in August, 1961.

CONTENTS

FOREWORD

This report comprises summaries of work concluded during 1958 to 1961 and reviews of work in progress. Further information is available from the Superintendent or the Head of the Section involved.

When the Research Branch was established in 1959 by amalgamation of Science Service and the Experimental Farms Service, the work at Lacombe was reorganized under three sections: (1) Livestock Section, to conduct breeding research with beef cattle, swine, poultry, and small animals; (2) Plant Breeding Section, to develop and evaluate varieties and strains of cereal, forage, and horticultural crops for central Alberta; and (3) Crop Management and Soils Section, to study weed control, soil fertility, crop rotations, and tillage. Though the primary objective of the program is to solve problems of production in central Alberta, many of the research findings have a far wider application.

Of major significance during the period was the Canada-wide release of breeding stock of the Lacombe breed of bacon hogs. Not only was this the first breed of pigs developed in Canada but its development confirmed several principles in animal improvement. Its selection was based on performance and this principle was incorporated into the registration regulations by requiring certain standards of performance for registration. This is the first time that selective registration has been applied to swine in North America and its impact is being followed very closely.

In comparisons of cereal varieties, the importance of controlling size and source of seed was demonstrated.

In cooperation with other research units, barban and Avadex were found promising in the control of wild oats; and the Farm contributed significant information on modes of action and methods of application.

These results, and others, have been reported annually in summaries entitled "Research Hi-Lites." In addition to the publications listed at the end of this report, results of research have also been released through press articles, field days, short courses, radio, and television.

February, 1962

J. G. Stothart
Superintendent

WEATHER

Meteorological data have been recorded daily at Lacombe since 1907. The following is a review of the factors that may have affected experimental and production results from 1958 to 1961. The detailed records are available on request.

The total precipitation recorded in each of the four years was well below the 54-year average of 17.74 inches, the total in 1961 being only 12.20 inches, the lowest ever recorded at Lacombe. In 1958, 1959, and 1960 the totals were 15.28, 16.04, and 14.69. Grain yields in 1961 were high in spite of the low precipitation. Noteworthy were the above-average yields in 1958, when rainfall was above the long-term average in May and June but nearly two inches below in both July and August; hay and pasture production was reduced by the summer drought. In 1959 low rainfall in May and June reduced forage production but the effect was not as severe on grain crops because of abnormally high rainfall in July. In 1960 rainfall was somewhat below average throughout the growing season but yields of grain were near normal. In 1961 only two effective showers were received, one in May and one in mid-July. The latter precipitation was particularly beneficial to the later-sown coarse grains and prevented a complete failure of the forage crops.

Moisture reserves in the soil were seriously reduced by this succession of dry years. Water levels in sloughs and lakes were also greatly lowered. Records of soil moisture for 1955-61 at various depths on cereal stubble showed a steady decline below the 12-inch depth, from near field capacity to near the permanent wilting point. Above-normal precipitation occurred in each of the years 1953 to 1956.

The monthly mean temperatures from 1958 to 1961 were considerably higher than the 54-year average, September and November excepted. The higher averages tended to be due to higher mean minimums than to higher maximums. However, the mean maximum temperature for June, 1961, was a record 79.1° F., 11.2 degrees higher than the long-term average and 4.3 degrees above the previous record for June made in 1921. The hours of bright sunshine also showed a marked increase during this period. In spite of the higher mean minimums, the annual frost-free periods (above 28° F.) varied as usual: 84 days in 1958, 103 in 1959, 116 in 1960, and 120 in 1961. The long-term average is 116 days and the 1958 season was the shortest on record.

Average wind speeds for the period were above the long-term average. Fortunately the increase did not cause serious, prolonged, or widespread soil drifting, presumably because of improved cultural practices.

The above-average sunshine and wind caused higher-than-average evaporation during the period. The inches of moisture evaporated in June, July, and August in the four years, with the long-term averages in parentheses, were: 5.17 (3.62), 4.62 (4.32), and 4.09 (3.66).

LIVESTOCK

The major work of the livestock section is breeding research with beef cattle, swine, poultry, and small animals. Some physiological studies are also conducted with swine.

65002-8—2

Beef Cattle

A large-scale selection study with beef cattle was begun in 1958 in cooperation with the experimental farms at Scott and Indian Head, Saskatchewan, and Brandon, Manitoba. All calves produced in the herd of 244 breeding cows at Lacombe are weaned at six months of age and individually fed until they reach a year of age. Selection of replacement breeding stock is based on weight at one year. A control herd is maintained to permit separation of genetic and environmental trends in performance.

Performance in relation to environment.—The relationship between calf performance and age of dam was examined through analysis of performance data for 680 calves raised at five locations in four years. The effect of age of dam was, on the average, the usual one. As age of dam increased, the weight of her calf at birth, weaning or later ages likewise increased until the dam was about seven years old. Calf weights decreased gradually as age of dam increased beyond seven years. The magnitude of the differences due to age of dam depended on the year and location of test, and an average correction for them was inadequate. However, certain performance traits, notably rate of gain and feed utilization during the postweaning period, were not influenced by differences in age of dam. It was concluded that minimum use of correction factors was desirable for evaluation of the growth potential of calves and that performance test procedures should give emphasis to measurement of those genetically important traits least influenced by age of dam.

Swine

Investigations with swine have included breeding and selection, evaluation of methods for measuring carcass quality, examination of factors that may influence the interpretation of genetic differences, and physiology.

Distribution and performance of the Lacombe breed.—The Lacombe breed of swine, developed through selection and controlled inbreeding from a hybrid foundation based on the Berkshire, Landrace, and Chester White breeds, was admitted to registration by Canadian National Livestock Records in November, 1957. In the next three years, breeding groups, each consisting of three gilts and a boar, were distributed to private breeders across Canada. By January, 1961, 462 breeding females and 151 boars had been distributed and the breed was well on the way to being self-sustaining in the hands of private breeders.

The Canadian Lacombe Breeders Association was formed in 1959 and incorporated under the Livestock Pedigree Act in 1959. At the close of 1961, membership in the breed association stood at 152 and 4,590 pedigree certificates had been issued for this breed. Registrations of Lacombes during 1961 totaled 2,090, or about 10 percent of the total for all breeds of swine in Canada during the year.

Throughout the development of the Lacombe breed, selection was based on factors influencing economic production. Pigs chosen for breeding were vigorous, growthy, and physically sound, and their sibs excelled in carcass quality, rate of growth, and feed efficiency. Attention was also given to teating, at least 14 normal teats being required for both sexes.

Continuity of these selection standards was ensured through adoption by the Canadian Lacombe Breeders Association of a program of selective registration. Standards were set for growth rate, carcass quality and feed utilization, and performance testing was made requisite. Records of performance for the

Lacombe, Landrace, and Yorkshire breeds for 1959-60 and 1960-61, compiled from test stations across Canada, averaged as follows:

Year	*Breed*	*No. of litters tested*	*Days of age at slaughter*	*Pounds of feed per 100 pounds of live gain*	*Carcass score*
1959-60	Yorkshire	848	186	353	76
	Landrace	146	185	372	76
	Lacombe	129	172	350	77
1960-61	Yorkshire	732	182	346	76
	Landrace	147	178	352	79
	Lacombe	274	168	346	76

These figures show that Lacombes have given good carcass quality, rapid growth rate, and efficient feed utilization.

Litter size and postweaning performance.—Data for 135 gilt litters from 52 sires in four years were analyzed to determine the effect of weaned litter size on weaning weight, feedlot gain, and carcass quality. For each additional pig weaned in the litter the average weaning weight decreased by 0.5 pounds. However, litter size did not have any measurable influence on average daily gain in the feedlot or on the carcass traits of length, loin area, back fat thickness, and belly quality.

Rib and vertebral numbers in swine.—The numbers of ribs and vertebrae for 4,485 Lacombes, 1,299 Yorkshires, and 1,089 crossbred pigs were determined by radiography. The number of vertebrae (thoracic and lumbar) ranged from 20 to 23 and that of rib pairs from 14 to 17. The breed difference was small. Lacombes averaged 15.7 rib pairs and 21.9 vertebrae as compared with 15.6 and 21.8 respectively for the Yorkshire.

There was considerable variation within litters. A difference of one or more vertebrae, and of one or more rib pairs, between litter mates was observed in about 75 percent of the litters farrowed. Less than 12 percent of all litters farrowed were of uniform rib and vertebrae number. Mating of parents of identical rib and vertebral type did not reduce the variance for these traits within litters. Genetic studies of these data are continuing.

Use of radiography in carcass studies.—Measurements made from radiographs of 40 pigs during the postweaning period indicated that vertebral size and depth of back fat increased linearly over the weight range from 100 to 200 pounds. Veterbral size varied considerably between pigs of the same live weight, but vertebral size and number considered jointly gave reasonably accurate prediction of carcass length. The correlations between carcass measurements of shoulder and loin fat and the corresponding "spot" measurements from the radiograph were in the range of 0.6 to 0.7.

Prevention and treatment of anemia in baby pigs.—Hemoglobin levels, hematocrit values, and erythrocyte counts were determined at weekly intervals from 3 to 45 days of age for 60 pigs that received iron in the form of: injectable iron-dextran; injectable ferric ammonium citrate; oral paste; or sods sprinkled with iron sulphate. The iron-dextran and ferric ammonium citrate compounds were administered at 3 days of age as single injections supplying 100 mgm. of iron and 30 mgm. of ferric ammonium citrate respectively. The paste was administered at 3, 10, 17, and 24 days of age. Sods were fed twice a week during the period of 3 days to 28 days of age.

The sod treatment maintained normal blood values. Iron-dextran compounds and the paste were somewhat less effective, but prevented anemia.

65002-8—2½

Ferric ammonium citrate was unsatisfactory and two pigs on this treatment died at 42 and 60 days of age. Both had severe anemia.

Differences in weaning weights were statistically significant. The heaviest pigs were those receiving sods; the lightest, those receiving injectable ferric ammonium citrate. The effect of the different treatments on growth was not apparent until after 21 days of age.

Measurement of body composition in live animals.—In a physiological study in cooperation with Cornell University, blood volume and red cell mass were determined in rats and market hogs by the Cr^{51} labeled red-cell method, and the protein mass was determined by chemical analysis of the carcasses. For the rats, a correlation of 0.96 was found between red cell volume and protein mass of the entire body. For market hogs, the correlation was 0.82, based on the dressed carcass.

As the main problem in meat animal improvement now is to increase the percentage of lean tissue, this method of measuring body composition in the live animal may be useful for selection. Studies to evaluate this application are now under way. Application to a variety of biological problems will also be explored.

A comparison of methods evaluating carcasses.—The values of several carcass measurements for predicting carcass composition were compared.

Dressing percentage and ultrasonic measurement of the lean/fat ratio at the 13th rib proved of little value in predicting carcass composition. Average thickness of back fat showed a correlation of 0.69 with percentage carcass fat. The area ratios of lean/fat in the section close to the face of the ham and that at the 10th rib area showed high correlations with average back fat thickness (−0.73 and −0.80), percentage protein (0.66 and 0.80), and percentage fat (−0.70 and −0.86) of the carcass. Of the five cross sections studied, these two sections also showed the highest correlations of square inches of lean per 100 pounds of chilled carcass weight with percentage lean (0.87 and 0.88) and percentage fat (−0.96 and −0.94) of the carcass. Of the carcass measurements studied, specific gravity of the carcass showed the highest correlations with the percentage of protein (0.95) and fat (−0.995) of the carcass.

Poultry

Response to selection for egg production.—Selection of pullets and cockerels entirely on the basis of part-year records was conducted through four generations. In comparison with a control line, egg production increased almost linearly, by 5 and 8 eggs per generation for 275- and 500-day production respectively. Survivor egg production at 500 days for the selected strain reached 250 eggs. The selected line now reaches sexual maturity (first egg) 19 days earlier than the control. Body weight at housing (147 days) changed little but gain in weight from 275 to 390 days declined markedly in the selected strain. Laying house mortality averaged 2.9 and 7.1 percent for the selected and control strains respectively.

Relationship between egg production and egg quality.—Egg quality of the selected and control strains in the above experiment was evaluated in each generation. Egg weight and specific gravity fluctuated erratically. However, steady downward trends in albumen height and Haugh units were evident in the selected line. Incidence of blood spots in the selected line also increased, to 15 percent as compared with 10 percent for the control line. These changes suggest a negative genetic correlation between egg production and egg quality.

Hatchability in relation to egg shell quality.—Tests indicated that differences in egg shell texture, from porcelain-smooth to uniformly rough over the entire surface, may have an important effect on hatchability when fertile eggs are stored for more than one week or are stored under suboptimum conditions of temperature or humidity, or both. Prolonged storage under these conditions, though detrimental to all eggs, had the most pronounced effect on eggs of rough shell texture. In the poultry flock under selection, improved production levels were accompanied by a decline in egg shell texture. Simultaneously, hatchability decreased. Studies now in progress may clarify whether all or part of the decrease in hatchability may be attributed to the change in shell texture.

Small Animals

Reciprocal recurrent selection for body weight in mice, conducted in cooperation with the University of Edinburgh, gave no improvement in performance in four generations. The two strains used had a long history of selection for body weight but their fecundity at the start of the experiment was poor. Selection of the progeny obtained by crossing these strains increased the body weight. It was concluded that controlled outcrossing was preferable to reciprocal recurrent selection as a method for extending selection limits in long-selected strains of livestock.

Studies are now under way at Lacombe on response to selection for body weight in mice under different conditions of temperature and nutrition.

PLANT BREEDING

Plant breeding, adaptability studies, and allied research on crop species and varieties are the major aspects of study in the Plant Breeding Section. All breeding programs are conducted in cooperation with one or more of the Research Branch units and the University of Alberta. Those on wheat, oats, barley, red clover, and alsike clover are coordinated at Lacombe, and Lacombe personnel cooperate in the programs on bromegrass, intermediate wheatgrass, crested wheatgrass, potatoes, tomatoes, and prairie fruits.

With few exceptions, the adaptability studies are also cooperative projects. These involve evaluation of hybrids, strains, and varieties in advanced stages of testing and of licensed varieties for regional adaptation.

Allied research is directed towards improvement of methods and techniques in breeding, selection, and testing to ensure greater precision and accuracy in results.

Breeding is handicapped by a lack of efficient methods of predicting yield potential in early generations. Many selections are carried for several generations only to be discarded because they do not give high yield. Progress was made in establishing relationships between seedling growth, yield components, and yield potential and also in selecting for yield on the basis of single-plant performance.

Studies on importance of seed size in selection and testing procedures confirmed that size of seed must be considered in all selection and testing programs to avoid bias in experimental results. Wide differences in performance resulted from samples that varied in their proportions of large, medium, and small seeds.

Cereal Crops

The main problem in breeding cereal crops for central Alberta is to obtain early maturity without sacrificing high yield and other desirable characteristics.

Some diseases are important in the area but seldom do they seriously limit production. Rust on wheat is moderately serious in some years in the north-eastern section. Foliage diseases affect barley annually in varying degrees and smuts, particularly loose smut of barley, are common. Resistance to these diseases is sought through breeding.

A study was begun in 1959 on relationships between maturity, yield, and quality of wheat to improve methods of selecting for yield and quality in any maturity class. Parents in the initial cross were Prelude and C.T. 423. Through random sampling, 432 F_2-derived lines were increased to the F_6 generation by the end of 1961. Seed of these was to be increased in 1962 to permit yield and quality tests in subsequent years.

Since Prelude is bearded and has purple straw at maturity and C.T. 423 has tip awns and yellow straw, segregation for these characteristics in the F_2 generation was noted: 131 plants were bearded and 301 tip-awned; 140 had yellow straw and 292 had purple straw.

Wheat.—Four early-maturing Lacombe hybrid selections were placed in advanced stages of testing. One of these is as early as Saunders and appears to approach Thatcher in yield when grown in central Alberta. These selections were taken from several thousand lines in small plots and about 300 lines in preliminary yield trials.

In breeding for early maturity, Thatcher, Selkirk, Pembina, Reward, and several early-maturing introductions from foreign countries were freely crossed. Attempts are also being made to reconstitute Thatcher with early maturity by backcrossing. In the latter program the donor parent was an extremely early selection from Ruby, of good quality. Five backcrosses to Thatcher were made, and, though none of the lines obtained were as early as the donor parent, many were earlier than Thatcher.

In adaptability trials, Canthatch and Pembina, two newly licensed varieties, were tested extensively throughout central Alberta from 1959 to 1961. Canthatch (Thatcher^6 $\times$ Kenya Farmer) was similar to Thatcher in all respects. Since stem rust was not common during the period of testing, the greater resistance of Canthatch to races 11 and 15B did not contribute to performance. Pembina was as early as Saunders but did not yield as well.

Oats.—The association between date of maturity and yield in oats was studied in detail. When conditions were favorable for normal development of all maturity classes, late maturity and high yield were closely associated ($r = 0.64$). Hence, conventional methods of selecting early-maturing, high-yielding hybrids may evidently have little chance for success. Better use of the yield : maturity ratios (pounds of grain produced per day) could be made in selecting parents for crossing. It is also possible that random sampling, if used as a standard practice in the breeding program, would increase the chances of obtaining high-yielding, early-maturing lines.

Three Lacombe hybrid selections and one foreign introduction reached the advanced stages of testing. One was discarded and final decisions were not made on the remaining three. One is slightly earlier than Eagle and approaches it in yield. The others are considerably earlier and yield exceptionally well for their maturity class. These two selections have short, strong straw but have small kernels, which may counteract their desirable features.

Since the introduction of Rodney and Garry into central Alberta, greater emphasis has been placed on plumpness of kernel. Several crosses were made with Rodney and early-maturing introductions from various sources. An undesirable feature of some of the early-maturing introductions is the color of the hull, which ranges from black to light brown. According to F_2 counts

this coloring is controlled by two genes, which may be in allelic series, the lighter color being recessive.

In adaptability trials, Glen and Fundy, newly licensed varieties, were tested extensively for three years throughout central Alberta. Glen yielded considerably more than the standard varieties in the same maturity class and appeared to be suitable for general production throughout the area. Fundy matured slightly earlier than Glen but gave unsatisfactory yields.

Barley.—With barley the aim is to develop early-maturing varieties with resistance to smut, scald, and net blotch without sacrificing high yield or quality. By 1959 a number of scald-resistant lines having the resistance of Vantmore had been developed. These have since been used as base parents for further crossing and backcrossing to add genes for resistance to net blotch and smut and to obtain more desirable agronomic and quality features.

It was also confirmed that in any composite lot of barley a much lower percentage of large kernels were infected with loose smut than medium-or small-sized ones.

In 1960 and 1961 the effects of seed source of barley on test results were studied jointly with the Ontario Agricultural College, Guelph, Ontario; the Research Station, Lethbridge, Alberta; and the experimental farms at Brandon, Manitoba, and Beaverlodge, Alberta. Seed stocks with a common genetic origin for five varieties in 1960 and four in 1961 from five sources of propagation were used. Two years of testing indicated that source of seed can exert a considerable influence on test results. For a true measure of the genetic potential of a variety, this factor must be given more attention than it has in the past.

In adaptability trials from 1958 to 1961 the newly licensed varieties Swan, Herta, Traill, and Nord failed to equal the varieties recommended for the area. The varieties Betzes, Jubilee, Palliser, and Keystone require further testing to establish their adaptability to central Alberta.

Flax.—Redwing and Redwood are recommended for production on the Black and Brown soils of central Alberta and Redwing alone is recommended for the Gray soil zone. Redwood, if it matures without damage, usually outyields Redwing by 15 percent. Because of its late maturity, however, it is a hazardous crop in areas with a short growing season. Other varieties tested, including Marine, Raja, and Norland, were not superior to the above. Cree, included in the tests for the first time in 1961, is the same maturity class as Redwood and requires further testing.

Winter wheat and fall rye.—Though winter wheat and fall rye are not important crops in central Alberta, because of a lack of winterhardiness in present varieties, limited testing was conducted. In winter wheat, Kharkov 22 M.C. and Winalta, the newly licensed variety developed at the Research Station, Lethbridge, were the most hardy and are recommended where winter wheat is grown. In fall rye, Dakold and Antelope were the most winter-hardy but Petkus and Sangaste, two large-seeded varieties of European origin, outyielded the former when winterkilling was not severe.

Forage Crops

Research on forage crops features the breeding of red clover for resistance to northern anthracnose, caused by *Kabatiella caulivora* (Kirchn.) Karak., and winter crown rot; the breeding of alsike clover for resistance to winter crown rot; and evaluation of species, varieties, new strains and grass–legume mixtures. As the winters from 1958 to 1961 were below average in severity, adequate tests for winterhardiness in the area were not possible.

Red clover.—The synthetics developed earlier with resistance to northern anthracnose were evaluated. During the four years the two single-cut synthetics (derivatives of Siberian Red) produced 5 to 8 percent more forage than Altaswede but averaged 14 to 19 percent less in seed yields. A reselection program is under way to improve seed production. The double-cut synthetic (derived from Dollard) performed well under irrigation in southern Alberta but was inferior in more northern areas and in Eastern Canada.

Alsike clover.—Breeding work with alsike clover was begun in 1960. The original breeding material included diploid Canadian alsike, representing the prostrate growth type, diploid European strains, representing the erect type, and various tetraploid strains.

Phyllody, a virus disease not previously reported in Western Canada, caused fairly extensive damage in the alsike breeding nursery in 1961. This virus causes proliferation of the floral organs into leaflike structures (Figure 1) and therefore reduces seed production greatly.

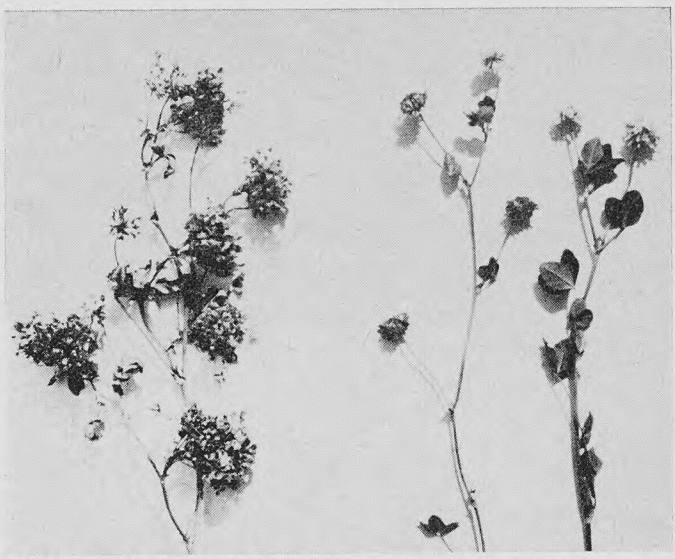

Figure 1.—Left, phyllody-infected shoots of alsike clover; right, healthy shoots.

Adaptabilities of introductions.—At introduction nurseries at Lacombe on Black soil, at Leslieville on peat soil, and at Chedderville and Athabasca on Gray Wooded soils, various forages were rated for adaptability as follows:

Unsatisfactory: Canada and Virginia wild rye, Norlea and common perennial ryegrass, big bluegrass and Canada bluegrass, Seaside and Colonial bentgrass, meadow foxtail, tall oatgrass, Alta tall fescue, chickpea and Swiss milkvetch, crown vetch, sainfoin, strawberry clover, zigzag clover, common and Ladino white clover, quaker comfrey, sorghum almum, fodder kale, and dwarf Essex rape.

Winter-hardy but with limited value: Tall wheatgrass, Sodar streambank wheatgrass, green needlegrass, sheep fescue and chewings fescue, and Sturdy meadow fescue.

Satisfactory: Carlton and Manchar bromegrass, Nordan, Summit, and Fairway crested wheatgrass, Chief intermediate wheatgrass, Mandan pubescent wheatgrass, Hercules, Frode, and Chinook orchardgrass, Frontier reed canary-

grass, Tammisto, Medon, and Climax timothy, Olds creeping red fescue, Russian wild rye, and Kentucky bluegrass.

Variety and strain testing.—Alfalfa: Average production in tons of dry matter per acre for a number of alfalfa varieties from 1959 to 1961 was as follows: Ladak, 1.72; Beaver, 1.64; Rambler, 1.49; Vernal, 1.47; and Grimm, 1.45. National tests indicated wide adaptability for Beaver and, because of its high resistance to bacterial wilt, it is one of the best varieties. Although Rambler yielded somewhat less hay, it is recommended for pasture mixtures because of its creeping-rooted habit.

Sweet clover: Cumino, the coumarin-free variety developed at the Research Station, Saskatoon, Saskatchewan, has been disappointingly low in seed yield in central Alberta. It matures about two weeks later than the highest-yielding varieties, Arctic and Erector. Seed crops of Cumino may therefore be damaged by early-fall frosts.

True clovers: In addition to diploid true clovers, European tetraploid varieties of red and alsike clover were also evaluated. In general, tetraploids were too late maturing and too low in seed yields for commercial production.

Birdsfoot trefoil: Pure stands of birdsfoot trefoil gave excellent yields from 1959 to 1961, even under dry conditions. As mentioned previously, winter-killing during this period was relatively light and further study is necessary to determine the place of this crop in central Alberta's farming program.

Bromegrass: In tests from 1956 to 1961 varieties of the Northern type continued to outyield Southern ones by averages of 7 and 86 percent for forage and seed respectively. Carlton, licensed in 1961, outyielded Manchar, the presently recommended Northern variety, by 0.05 tons of forage and 149 pounds of seed per acre.

Crested wheatgrass: Over a seven-year period varieties of the Standard type, Summit and Nordan, yielded 2.10 and 2.06 tons of dry matter per acre compared with 1.92 tons from Fairway.

Intermediate wheatgrass: This grass proved highly productive. Chief, licensed in 1961, and several other strains developed in the breeding program coordinated by the Research Station, Saskatoon, showed superiority over introductions from the United States.

Timothy: From 1956 to 1960, Tammisto and Medon yielded an average of 0.81 tons of dry matter per acre compared with 0.71 tons from Climax at Lacombe. These yields were far below those obtained from many of the other adaptable grasses. However, timothy is still a valuable crop in mixtures with legumes where rainfall is plentiful.

Reed canarygrass: Frontier yielded an average of 1.91 tons of dry matter per acre and Commercial 1.79 tons from 1956 to 1961. These yields compare favorably with those obtained from other grasses and indicate the tolerance of reed canarygrass to dry conditions even though it is generally recommended for areas subject to flooding.

Orchardgrass: Two seedings were made to compare the performance of varieties and selections of orchardgrass from 1957 to 1960. Hercules, Frode, and Chinook averaged 1.30, 1.22, and 1.11 tons of dry matter per acre. The hardiest variety, Chinook, might well have been relatively better had normal winter injury occurred.

Pubescent wheatgrass: This grass was subjected to very limited testing but appeared to compare favorably with intermediate wheatgrass. Mandan and Commercial were superior to Topar in these preliminary trials.

Grass–legume mixtures: In general, mixtures of bromegrass and alfalfa were the most widely adapted to central Alberta. Under certain soil and

climatic conditions, however, other grass-legume mixtures proved just as productive. For example, timothy and red or alsike clover were highly satisfactory mixtures for the Gray Wooded soils.

Usually the grass–legume mixtures outyielded grasses grown alone. In some cases this did not hold true until the third and subsequent crop years, when legumes became firmly established. Rarely was there any yield advantage through including more than one grass and one legume in a mixture.

Plots seeded in 1958 at Lacombe to compare various grasses when seeded with alfalfa for hay production gave average yields in tons of dry matter per acre from 1959 to 1961 as follows: bromegrass, 1.90; intermediate wheatgrass, 1.82; crested wheatgrass, 1.69; reed canarygrass, 1.51; timothy, 1.46; Russian wild rye, 1.39; and creeping red fescue, 1.25. Russian wild rye and creeping red fescue were more suited for pasture than hay. Consistent increases were recorded in succeeding years with all grasses except timothy and creeping red fescue. The comparatively dry conditions in 1961 may have accounted for the poorer performance of these grasses in that year.

Annual fodder crops.—Several varieties of oats and barley, millet, adaptable varieties and hybrids of corn, and mixtures of oats with peas, sweet clover, and corn were evaluated for annual fodder crops.

Late-maturing varieties of oats grown alone gave higher yields of dry matter and protein than any of the other crops, including mixtures. Corn averaged about one ton less dry matter per acre than the best varieties of oats. Millet approached the yield of oats in hot dry seasons but gave considerably lower yields on the average. Oat–corn mixtures outyielded corn grown alone while oats mixed with peas and with sweet clover gave yields slightly less than oats grown alone.

Since 1959, 25 varieties and introductions of oats have been tested to determine their relative values for hay and ensilage. Three-year average yields of dry matter per acre ranged from 1.83 to 2.72 tons. Protein yields ranged from 548 to 820 pounds per acre. Carotene content ran from 14.1 to 26.8 mg. per pound.

Oilseed crops.—Rapeseed production has become firmly established in central Alberta. In a four-year period at Lacombe, Polish and Arlo (Polish types) yielded about 2,000 pounds of seed and 830 pounds of oil, whereas Argentine and Golden (Argentine types) yielded 1,450 pounds of seed and 610 pounds of oil. The Polish types matured some two weeks earlier than the Argentine and usually escaped damage from early-fall frosts. Argentine types are not recommended in central Alberta.

Sunflowers are a hazardous crop in the area because of the late maturity of present varieties and hybrids.

Horticultural Crops

Though commercial interest in horticultural crops in central Alberta is limited primarily to nurserymen, market gardeners, and potato producers, homeowners, both rural and urban, show a keen interest in improving production from their home gardens and in beautifying their home grounds. Variety and strain testing and evaluation of strains and species for specific uses are important phases of the horticultural work at Lacombe.

In cooperation with the Research Branch units coordinating the breeding programs for potatoes, tomatoes, and prairie fruits, selection work is in progress to develop and propagate species, varieties, and strains especially adaptable to central Alberta.

Potatoes.—Early tuber formation is important in early market potatoes. This characteristic must not be confused with early maturity, since many midseason and late-maturing varieties form sizeable, but far from mature, tubers at an early stage.

In yield trials, Warba, the standard early-maturing type for central Alberta, yielded 170 bushels per acre of marketable tubers in 85 days from planting. Norland, a variety developed in North Dakota and licensed for sale in Canada in 1960, yielded 218 bushels in the same period. The latter has shallower eyes than Warba, has tubers more nearly uniform in shape, and is more resistant to common scab. Other varieties outyielded Warba and Norland but did not have satisfactory tuber characteristics.

Tomatoes.—The Cooperative Tomato Breeding Project for the prairies was begun in 1955 to develop a tomato that would ripen in 65 days or less from planting date and produce fruit weighing about 226 grams (8 ounces). At Lacombe, Morden BB.3 was chosen as the large-fruited parent to be backcrossed to an early variety, Earlinorth, as the recurrent parent. Because of the apparent sensitivity of Earlinorth to adverse weather conditions, resulting in severe fruit malformation, it was replaced in 1959 with Morden B4, an early-maturing, smooth-fruited variety. Average days to maturity for Earlinorth and Morden B4 were 78 and 70, and fruit size 74 and 50 grams, respectively. Selections in 1961 from lines with Morden B4 as the recurrent parent compared favorably with B4 in maturity and exceeded it in size by 60 grams. Though the initial objective was for relatively large fruit, six years of selection indicated that somewhat smaller fruit may have to be accepted for central Alberta if early maturity is to be retained.

Tree fruits.—The Farm joined in the Prairie Cooperative Fruit Breeding Project in 1954. Since then over 6,500 seedlings from controlled apple × crabapple crosses have been planted for selection. Thirty-six percent of the seedlings survived roguing based on vigor, winterhardiness, resistance to disease, and, more recently fruit characteristics. Fruiting began in 1959 and 1960, and by 1961 4.5 percent of the surviving seedlings had fruited. Many showed promise for size and quality of fruit. Seedlings from Rescue × Trail cross showed the largest percentage of fruited seedlings in 1961, 12 out of 55 developing fruit.

Vegetables.—Newly developed varieties and strains of vegetable crops were evaluated annually. The findings were used in the periodic revision of the *Alberta Horticultural Guide.* Findings in special studies only are reported below.

Polyethylene mulches can aid production: Under normal conditions at Lacombe, polyethylene mulches increased production of sweet corn, cucumbers, and muskmelons. In 1960, Altagold sweet corn mulched with 2-mil clear polyethylene matured 14 days earlier and yielded 70 percent more than unmulched plots. Marketer cucumbers with the same mulching matured 4 days earlier and yielded 300 percent more than unmulched plots. Production increased 2,000 percent with muskmelons although the mulching did not affect maturity.

In 1961 the mulches had little effect on the above crops. Temperatures were above average and soil moisture was lacking in the early part of the season. Mean air temperatures were 9.2, 1.4, and 4.3 degrees Fahrenheit higher than the long-term average for June, July, and August. Under these conditions sweet corn, cucumbers, and muskmelons yielded well without mulches, averaging 300, 1100, and 2000 per cent higher than unmulched plots in 1960.

Hybrid onions prove valuable: The hybrid variety Autumn Spice averaged 1.2 pounds of marketable bulbs per foot of row (bulbs 4 inches apart) from 1959 to 1961. These yields were 33 and 42 percent higher than those obtained

from onion sets and imported transplants of the Spanish types. The yields were about the same as for the standard variety, Yellow Globe Danvers, but the bulbs matured 17 days earlier. Newer hybrids, including Aristocrat, Early Harvest, and Encore, also showed considerable promise.

Transplants versus field-sown seeds: The above yields of Autumn Spice were obtained from seed sown indoors about 30 days before field planting. By comparison, field-sown seed averaged 14 pounds less per row and two weeks later in maturity.

Ornamentals.—A number of species were planted for hedges just after the Farm was established in 1907. Many of these have been maintained throughout the half century, and four species that continue to thrive are *Caragana arborescens* Lam., Siberian peashrub; *Caragana pygmaea* DC., pygmy peashrub; *Picea glauca* (Moench) Voss, white spruce; and *Syringa josikaea* Jacq., Hungarian lilac. Both caragana species made excellent recovery from several extensive cutbacks. *Caragana pygmaea* has been kept about 3 feet high; its slow growth lends itself to this purpose. The other three species have been kept 6 to 8 feet high.

Six uncommon woody ornamentals with merit: The following woody ornamentals were found to be well adapted to central Alberta: *Atraphaxis buxifolia* (Bieb.) Jaub. & Spach, sometimes called the buckwheat bush; *Euonymus alata* (Thunb.) Sieb., winged euonymus; *Genista tinctoria* L., common woodwaxen; *Prunus virginiana melanocarpa* (A. Nels) Sarg. 'Shubert', Shubert chokecherry; *Prunus virginiana xanthocarpa* Sarg.; and *Sorbus decora* (Sarg.) Schneid., showy mountain ash.

CROP MANAGEMENT AND SOILS

Soil Fertility

Fertility experiments were conducted with cereals on fallow and on stubble and with forage crops in the Dark Brown, Shallow Black, Black, Degraded Black, and Gray Wooded soil zones. Emphasis was placed on the response to rates and ratios of nitrogen and phosphorus.

For grains on fallow.—Field trials in all soil zones continued to show that phosphorus fertilizer drilled in with the seed gave the greatest increase in yield of grain grown on fallow. At many locations, a linear response was obtained, including even the highest rate, 40 pounds of P_2O_5 per acre. Consistent increases from nitrogen were obtained at only one location, in the drier part of the area.

For grains on stubble.—Cereals on stubble land varied considerably more in response to fertilizer than those on fallow. This variation was evident within trials in any one year, between years at the same location, and between locations in the same year. In general, phosphorus gave a moderate increase in yield whereas the response to nitrogen was highly variable. This variability confirms the need for individual farm tests for use of nitrogen on stubble.

For hay and pasture.—Forage crops (generally alfalfa–bromegrass mixtures) in the Black and Degraded Black soil zones responded largely to phosphorus, and showed a small but consistent increase from nitrogen. In the drier Shallow Black and Dark Brown zones they responded largely to nitrogen and showed only slight increases from additions of phosphorus. Residual responses in subsequent years were similar to those obtained the year of application but were generally smaller. The results emphasized that the fertilizer requirements

of forage crops vary greatly depending on kind of crop, moisture conditions, and soil. In general, deep loams continued to respond profitably in dry seasons, whereas light-textured soils did not.

Bromegrass responded markedly to phosphorus on deep loams whereas alfalfa–brome mixtures responded to a combination of nitrogen and phosphorus. On lighter soils, alfalfa–brome continued to respond to the combination of nitrogen and phosphorus as did pure grasses. Pure grasses and grass–legume mixtures on sandy and stony soils responded mainly to nitrogen, but usually only slightly.

Though fall applications were reported earlier to be more effective than spring applications, there was little difference in effectiveness from 1958 to 1961.

Rotations.—Applications of nitrogen or phosphorus were found to be of little benefit on sulphur-deficient Gray Wooded soils, either alone or in combination, unless they were applied to crops in rotations that included legumes fertilized with sulphur. Annual applications of fertilizers at the Chedderville experimental project farm were more effective than applications every third year of the same total amount of plant nutrient. Nitrogen and phosphrus (plus sulphur) gave higher yields than nitrogen alone (plus sulphur).

Sulphur fractions of legumes as indicators of sulphur deficiency.—At 157 locations in west-central Alberta, yield increases of alfalfa, alsike clover, and red clover from applications of sulphur fertilizers were not confined to either specific soil series or definite geographical areas.

Samples of the three crops from 74 locations were analyzed to determine the usefulness of three sulphur fractions and of the ratio of total nitrogen to total sulphur as indicators of the need for sulphur fertilization. Extractable sulphur and extractable sulphate were present in considerably larger quantities in alfalfa and alsike clover grown on soils not deficient in sulphur than in samples grown on soils that were. These determinations offer a possible means of detecting sulphur deficiency through these two crops. Though total sulphur and the ratio of total nitrogen to total sulphur also varied with the sulphur status of the soil, the differences were not as great as for the other two fractions.

For red clover the differences in all determinations were smaller than for alfalfa and alsike clover and appeared to be of doubtful value for predicting the need for sulphur fertilization.

Pasture production.—From 1956 to 1961, three pasture swards—alfalfa–brome, brome, and creeping red fescue—under three levels of fertility were rotationally grazed by yearling steers and production was measured by animal gains and carrying capacity. An application of 400 pounds of 16-20-0 per acre doubled the beef production and gave higher net returns than either 200 or 800 pounds of 16-20-0. In addition, this rate of fertilization increased the carrying capacity to 114 animal-days from 77 animal-days where no fertilizer was applied. Alfalfa–brome, whether fertilized or not, produced more of both dry matter and beef.

Crop Sequence and Tillage

Sweet clover as a substitute for fallow.—In a four-year rotation (grain, grain, grain, sweet clover or fallow) on a deep Black loam soil, sweet clover was handled in four ways: harvested for hay and plowed immediately, harvested in June and plowed on September 15, plowed when 18 inches high, and plowed when in full bloom. In all cases but one, the yield of grain after sweet clover was equal to, but no better than, after fallow. Plowing the sweet clover aftermath on September 15 reduced the following wheat yield in each of the six years of this test.

Tillage studies.—Methods or machines used for fallow had no effect on soil moisture reserves at seeding time. However, the type of machine used had an effect on the amount of trash retained on the surface, wide-sweep cultivators retaining the most. Decomposition was rapid with all treatments, and usually after four operations less than 10 percent remained on the surface. Method of tillage for fallow had no effect on the yield of the subsequent crop. The method of preparing a seedbed on stubble affected the yield but the difference were inconsistent. The fall of 1960 was dry and fall plowing gave lower yields than other methods of fall and spring tillage. In two out of three previous years, fall plowing gave the highest yields.

Frequency of tillage (0 to 12 times) during the fallow year had no effect on grain yields provided weeds were adequately controlled. Fallow not tilled lost moisture during the summer because of weeds; though winter precipitation restored the moisture, weeds and other factors reduced yields.

Crop residues.—In a seven-year test, straw was handled in six ways: disced with the oneway in the fall, plowed in the fall, worked with the blade cultivator in the fall, chopped and disced with the oneway in the fall, disced with the oneway in the spring, and burned in the spring and then disced with the oneway. During the period, spring burning followed by oneway tillage gave a slightly higher average yield of wheat than any other treatment, whereas oneway discing in the spring alone gave the lowest yield. Burning in the spring and plowing in the fall gave much better control of a severe wild oat infestation than other treatments.

Cover crops.—Experiments begun in 1930 showed that seeding spring wheat or oats about August 1 at 0.5 or 1 bushel per acre, respectively, gave excellent protection from wind erosion for fallow land. Because these studies showed that this practice did not appreciably reduce the yield of the following grain crop, the value of the cover crops as fall pasture was studied. Seeding oats at 2 bushels per acre in mid-July significantly increased the yield of cover crop. The increase more than offset in value the slight reduction in yield of the succeeding wheat crop caused by seeding the cover crop earlier. Oats gave the highest yields of cover crop, followed closely by barley and wheat. Fall rye and winter wheat gave very low yields (pasture) at either date of seeding. Fall rye, and to a lesser extent winter wheat, seriously reduced the yield of the succeeding wheat crop. This may be partly attributed to the difficulty of killing the rye in preparation for seeding the following spring.

In small-plot trials, Eagle oats seeded as above yielded an annual average of 3,590 pounds of dry matter from 1957 to 1959.

Early swathing of barley.—In a four-year test, Vantage and Olli barley were swathed daily with kernel moisture content ranging from 50 down to 14.8 percent. Kernel moisture content at swathing was negatively correlated with weight per bushel and yield down to 40 percent. From 40 percent to maturity it did not affect either significantly.

Weed Control

Wild oats (Avena fatua).—Barban. In cooperation with several institutions in Western Canada, selective control of wild oats in cereals was obtained with barban (4-chloro-2-butynyl *N*-(3-chlorophenyl) carbamate; Spencer Chemical Co., Merriam, Kansas) in 1958.

In studies from 1959 to 1961, stage of growth of the weed was found to be the most critical factor in effectiveness. Generally, control decreased with increasing plant age. The number of wild oat plants in a natural field infestation

was reduced most, nearly 40 percent in 1959 and 50 percent in 1960, when barban was applied at 8 or 16 ounces (rates of herbicides are given in amounts of active ingredient or acid equivalent per acre) in 6 gallons of water when most of the wild oats were in the 1½- to 2-leaf stage. The surviving plants were retarded, and tillering was significantly reduced. The chemical tended to suppress growth and development rather than to kill the plants. The 8-ounce rate gave significant increases in the yield of wheat in both years, but the 16-ounce rate injured the crop.

In natural infestations, survival of some wild oats even at 16 ounces of barban per acre was due largely to uneven emergence of the weed. In an artificial infestation, when the wild oats were uniformly at the 1½- to 2-leaf stage at spray time as little as 4 ounces gave satisfactory control.

Increasing the volume of diluent from 5 to 30 gallons of water per acre greatly reduced the effectiveness of barban. Varying the spray pattern through the use of hollow-cone and single- and double-fan nozzles did not consistently influence effectiveness. Although greatly reduced in numbers by all treatments, the wild oat seeds that matured were viable. Application of phosphorus to a soil deficient in this nutrient increased the control. Selkirk wheat was somewhat more susceptible to barban than Thatcher, and Olli barley was more susceptible than either Husky or Gateway. All oat varieties tested were highly susceptible. Flax was tolerant to 6 ounces of barban applied after the cotyledon stage but before the plants had 14 true leaves.

Avadex: In screening trials in 1958, Avadex (2,3-dichloroallyl diisopropylthiolcarbamate; Monsanto Chemical Co., St. Louis, Mo.) sprayed on the soil and incorporated to a depth of 2 to 3 inches gave selective control of wild oats in flax and barley. In extensive field plot tests in 1959 and 1960, the number of wild oat plants was reduced 85 percent when Avadex was applied at 1.5 pounds and disced in on the same day to a depth of 2 or 3 inches. Flax was highly tolerant to this treatment, barley was considered tolerant, but wheat and tame oats were susceptible.

Laboratory experiments showed that Avadex affected mainly the coleoptile rather than the root system in both wild oats and wheat. The two species differed in degree affected, depending on stage of development when they came in contact with treated soil, concentration of the herbicide, and length of time that the coleoptile was in contact with the treated soil. Wild oats and wheat were highly sensitive until the coleoptile was ½ inch long, and wild oats also about the time when the crown node was initiated. Therefore, if wheat was planted at least ½ inch below the layer of treated soil, selective control of wild oats in wheat was possible. However, the relative placements were critical. In the field, the practice of seeding the crop to a depth of 3 inches just before spraying and discing to a depth of 2 inches gave a good margin of safety for barley and wheat at Lacombe. The pattern of response was similar in soils of different textures, but herbicidal activity was higher on the heavy clay than on loam soils. Other studies showed that Avadex was not readily moved in the soil by water and, although the chemical underwent a rapid initial breakdown, it had some effect on oats in the year after 2 pounds were applied.

Tartary buckwheat (Fagopyrum tataricum (L.) Gaertn.).—In north-central Alberta over 500,000 acres are heavily infested with tartary buckwheat. The weed is a strong competitor and difficult to control with tillage. Because of its seed size and shape it is particularly difficult to remove from wheat and often causes the grain to be graded "Rejected." The esters of 2,4-D, especially the butoxy ethanol ester applied at 6 to 8 ounces during the first or second true-leaf stage, greatly suppressed its growth but did not eliminate seed setting. Although less effective, the esters of MCPA at 8 to 12 ounces

were safer to use in flax and oats or when very early spraying was necessary in wheat and barley.

Among the selective herbicides studied during 1957-1959, Kloben Neburon (1-*n*-butyl-3-(3,4-dichlorophenyl)-1-methylurea; DuPont of Canada Ltd., Montreal) was the most effective. When applied when moisture was adequate before the weed was in the 4-leaf stage, it was highly satisfactory at 2 pounds. Large volumes of water, about 100 gallons per acre, were required for uniform application. Because of this and its high price, few farmers have used it. At similar rates, Kloben Neburon was equally effective on seedlings of corn spurry, *Spergula arvensis* L.

A new benzoic acid compound appeared very promising for the selective control of both of these species.

Canada thistle (Cirsium arvense L.).—Emphasis was directed toward finding a herbicide that would destroy not only the top growth but also the rhizomes of this weed, without adverse residual effects. A combination of tillage and spraying on fallow land was the most effective, giving about 90 percent reduction in stand in the year after treatment. The treatment consisted of three steps: tillage up to mid-June to destroy annual weeds and volunteer grain; spraying with 2,4-D ester at 16 ounces when the thistles were in bud; resumption of tillage about 4 weeks later or when regrowth appeared, to keep the area black until freeze-up. Amitrole (amino triazole), 2,3,6-TBA, (2,3,6-trichlorobenzoic acid), and 4-(2,4-DB) were as effective as 2,4-D but were more costly. In some trials, two new benzoic compounds and 4-(2,4-DB) appeared to be even more effective than 2,4-D.

Herbicides as an aid in establishing forage legumes.—Stronger stands of legumes are usually obtained by seeding without a companion crop of grain, if weeds are controlled. Alfalfa and red and alsike clovers but not sweet clover, seeded without a companion crop, were sprayed during the first trifoliate-leaf stage with an amine of 2,4-D at 3 to 4 ounces or an amine of MCPA at 4 to 6 ounces. Each treatment suppressed or killed such common annual weeds as stinkweed, ball mustard, lambsquarters, and hemp nettle and gave higher yields of forage in the establishment year than when a companion crop was used. Alfalfa was very tolerant to the butyl ester of 4-(2,4-DB) at the first trifoliate-leaf stage.

On the basis of total production of dry matter, the companion crop of oats harvested as grain plus the yield of alfalfa the following year was higher than the two crops of alfalfa obtained when no companion crop or herbicide was used. When herbicides were used, alfalfa seeded without the oat companion crop gave slightly higher total production during the two years. There was no evident increase in yield in the second year attributable to herbicide treatment in the establishment year.

Sweet clover was more susceptible to these treatments than alfalfa, and spraying with MCPA amine at 4 ounces was justified only when weed growth was extremely heavy.

Wild oats were controlled without injury to alfalfa or sweet clover by either a postemergence application of barban at 6 ounces or a preplanting application of Avadex at 1.5 pounds.

SOIL RESEARCH SUBSTATION, VEGREVILLE

Solonetzic soils cover more than 15 million acres in Western Canada, almost 10 million acres being in Alberta and the remainder in Saskatchewan and Manitoba. They occur mainly in the Black, Dark Brown, and Brown soil zones. That they present serious production problems has been known for some time.

The four main Solonetzic soils in order of productivity are Alkali Solonetz, Solonetz, Solodized-Solonetz, and Solod. They often occur in association with even less productive saline soils and with normal soil. Identification is based mainly on the condition of the B horizon.

The Solonetzic soils represented at Vegreville are the Duagh–Wetaskiwin–Malmo complex. The Duagh is a typical Alkali Solonetz, the Wetaskiwin a Solodized-Solonetz, and the Malmo a Solod. Duagh contains more soluble salt in the A horizon than is usual in these soils. Though most of the Solonetzic soils in Alberta are studied in the greenhouse and the laboratory at Vegreville, only the Vegreville soils are dealt with in this report. Some work is conducted in cooperation with the Research Station, Lethbridge, and the Alberta Soil Survey at Edmonton.

Soil Chemistry

Soluble salt is abundant within 36 inches of the surface in the profile of each soil except the Solod. The main salt is sodium sulphate but the quantity of magnesium sulphate is appreciable. With increasing depth in all soils except the Solod, the electrical conductivity of the saturation extract increases rapidly.

Study of the quantities of cations extracted with ammonium acetate showed that the Ca:Mg ratio is less than 1 in the A and B horizons of the less productive soils, the Ca+Mg:Na ratio less than 2, and the Ca:Na ratio less than 1. The Ca:Mg ratio in the Solod is 3.17:1 and the other ratios proportionately greater than in the other soils.

There is practically no gypsum or carbonate concentration within the first foot of any of the soils. In the second foot there is a marked concentration, particularly of carbonates. In the Solod there is no gypsum concentration, and the carbonate concentration is somewhat deeper than in the others.

The organic matter content of the surface layers varies greatly, and ranges from about 6 percent in the Alkali Solonetz to about 12 percent in the Solod. The C:N ratio is also very variable, and averages about 12 in the Solod and 13 in the Alkali Solonetz.

Soil Physics

The A horizon of the various soils is a silt loam. The Alkali Solonetz crusts severely and water infiltrates into it slowly whereas the Solod has little tendency to crust and water penetrates it freely.

The clay content of the B2 horizon of the various soils does not vary greatly. The percentage of clay in the B2 horizon of the Alkali Solonetz is 40 as compared with 39 in the Solod. However, the silt and sand fractions vary greatly in this horizon. The sand content is higher in the B2 horizon of the Solod. The disturbed hydraulic conductivity is zero in this horizon of the Alkali Solonetz and over 1.00 inch per hour in the Solod.

Undisturbed hydraulic conductivity of the Alkali Solonetz is negligible except in the A horizon, but the Solod exhibits reasonably good conductivity except in the B2 horizon. The wilting percentage atmosphere (15-percentage) is about 19 in the A horizon of the Alkali Solonetz and ranges from 26 to 31 in the same horizon of the Solod. The field capacity (one-third-atmosphere percentage) is about 37 percent in the Alkali Solonetz and ranges fom 41 to 45 in the A horizon of the Solod. In the B2 horizon of the various soils these values are practically uniform.

Plant Nutrition

Greenhouse work revealed that the A horizon of the Alkali Solonetz is incapable of sustaining growth of barley seedlings. Though applied gypsum

did not promote plant growth, applied sodium sulphate, the other abundant salt in the lime–salt layer did. Heating (55° or 110° C.) the soil between crops also promoted productivity. The nutritional disorder is caused by an inadequate release of soil nitrogen. In the field, nitrogenous fertilizers produced up to fourfold increases in the yield of brome.

Soil Amendments

The use of sulphur, gypsum, manure, straw, krilium, and other materials designed to improve the physical condition of the soils was studied for five years. Results have been discouraging even with gypsum, which is commonly considered an ameliorant for Solonetzic soils.

Root Penetration and Water Content in Soil Profiles

Roots of bromegrass readily penetrate 7 to 8 inches into the Alkali Solonetz soil and 16 to 18 inches into the Solod. There is a marked tendency for the moisture content of the profile of the Solod to fall below the wilting point, particularly below the 12-inch depth. The Alkali Solonetz does not exhibit this tendency. There is little indication that bromegrass procures any appreciable quantity of water from a depth of more than 12 inches in the Alkali Solonetz soil.

Soil Management and Methods of Seeding

Ease of seedbed preparation on Alkali Solonetz soil varies markedly from spring to spring. The precise factors causing this variation are as yet undetermined but are thought to include moisture and salt content. Both of these values vary widely from season to season. The poor emergence of seedlings in Solonetz soils can be largely overcome by preparing a fine, firm seedbed and drill-seeding into moist soil. Emergence is best when it occurs before crusting is caused by rain. Crusting is not severe after emergence. The preparation of an adequate seedbed is sometimes easily attained with the oneway disc, but in other years the use of the double disc is required. Seedbed packing is desirable.

Forage Crops

Brome is the most productive grass at Vegreville. Intermediate wheatgrass shows some promise, but cannot be generally recommended. The productivity of legumes, particularly sweet clover, is disappointing. One of the oft-suggested ameliorative practices for Solonetzic soils is the production of sweet clover. It is usually implied that the tap roots puncture holes in the B horizon, thus allowing water percolation, salt leaching, etc. Visual examination did not reveal a tendency for the roots of either alfalfa or sweet clover to penetrate appreciably into the B horizon of the Solonetz soil at Vegreville. Alfalfa is generally more productive than sweet clover, but a brome–alfalfa mixture did not consistently give more forage than brome alone.

No detailed study of seeding practices for forage crops has been conducted at Vegreville. However, from 1955 to 1958 all forages were broadcast and very poor and irregular stands were obtained. From 1959 to 1961, because of the evident desirability of seeding cereals with the press drill, the drill-seeding method was used for forage crops. Each year that drill-seeding was practiced, establishment was excellent. Weather conditions may have had some bearing, but the results suggest that rapid emergence is as important for forage crops as for cereals on these soils.

PUBLICATIONS

Research

Allen, H. T. Polyethylene plastics in vegetables. Proc. west. Canada. Soc. Hort. 25-27. 1960.

Baenziger, H. Supernumerary chromosomes in crested wheatgrass, their cylological behaviour and breeding significance. Ph.D. thesis. University of Saskatchewan. 1961.

Black, W. N., and R. R. Cairns. The effect of varying levels of nitrogen, phosphorus and potassium and manure on the yield and starch content of potatoes. Canad. J. Soil Sci. 38: 1-7. 1958.

Bowman, G. H. Top crossing with Lacombe boars. Proc. Canad. Soc. Anim. Prod., N, 49-51. 1959.

Bowman, G. H. Measures of leanness in swine. Ph.D. thesis. Oklahoma State University. 1961.

Bowman, G. H., J. P. Bowland, and H. T. Fredeen. An appraisal of certain sources of environmental variation in the productivity of Yorkshire sows. Canad. J. Anim. Sci. 41: 220-229. 1961.

Cairns, R. R. Some chemical characteristics of a Solonetzic soil sequence at Vegreville, Alberta, with regard to possible amelioration. Canad. J. Soil Sci. 41: 24-34. 1961.

Cairns, R. R., and R. B. Carson. Effect of sulphur treatments on yield and nitrogen and sulphur contents of alfalfa grown on sulphur-deficient and sulphur-sufficient Grey Wooded Soils. Canad. J. Pl. Sci. 41: 709-715. 1961.

Cairns, R. R., and A. C. Richer. A comparative study of sulphur responsive and a non-responsive Grey Wooded soil. Canad. J. Soil Sci. 40: 246-254. 1960.

Church, S. R., and L. J. Anderson. Progress report, Grey Wooded soils substation, Athabasca, Alberta, 1947-1958. Can. Dep. Agric., Exp. Farm, Lacombe, Alta., processed circ. 1960.

Dodds, M. E., and D. A. Dew. The effect of swathing at different stages of maturity upon the bushel weight and yield of barley. Canad. J. Pl. Sci. 38: 495-504, 1958.

Doornenbal, H. The effect of certain oral and injectable ions on the blood of baby pigs. Canad. J. Anim. Sci. 39: 193-201. 1959.

Doornenbal, H. The relationship between chromium-51 determined red cell volume and the "lean body mass" in rats and pigs. Ph.D. thesis. Cornell University, Ithaca, N.Y. 1961.

Doran, W. J. Levels of grassland production. Proc. Canad. Soc. Agron., 30-33. 1961.

Doran, W. J., and S. R. Church. Factors influencing the establishment and productivity of forage crops. Proc. Canad. Soc. Agron., 75-79. 1961.

Fredeen, H. T. Crossbreeding with swine. Proc. Canad. Soc. Anim. Prod., W, V. 1958.

Fredeen, H. T. Radiographic studies of the vertebral column of swine. Proc. Canad. Soc. Anim. Prod., W, XIII. 1958.

Fredeen, H. T. Selection and swine improvement. Anim. Breed. Abstr. 26: 229-241. 1958.

Fredeen, H. T. The genetic improvement of swine. Commonwealth agric. Bur. Commun. 38. Edinburgh. 1958.

Fredeen, H. T. Some factors influencing pre- and post-weaning growth in beef cattle. Proc. Canad. Soc. Anim. Prod., 49-50. 1961.

Friesen, H. A. Effect of growth stage and volume of diluent on the control of wild oats with Carbyne. Proc. Joint Meeting no. cent. Weed Conf. and west. Canad. Weed Conf., Winnipeg, 35. 1959.

Friesen, H. A. The role of herbicides in the establishment of legume stands. Proc. Canad. Soc. Agron., 89-90. 1959.

Friesen, H. A. Factors influencing the performance of Avadex for wild oats control. Proc. no. cent. Weed Conf., 20. 1960.

Friesen, H. A. Crop rotations and herbicides for weed control in northerly parkland and wooded regions. Proc. Canad. Soc. Agron., 69-74. 1961.

Friesen, H. A. Some factors affecting the control of wild oats with Barban. Weeds 9: 185-194. 1961.

Friesen, H. A., and D. E. Forsberg. Neburon as a selective herbicide for Tartary buckwheat and wild buckwheat. Weeds 7: 47-54. 1959.

Kaufmann, M. L. Seed size as a problem in genetic studies of barley. Proc. genet. Soc. Can. 3(2): 30-32. 1958.

Kaufmann, M. L. Yield-maturity relationships in oats. Canad. J. Pl. Sci. 41: 763-771. 1961.

Kaufmann, M. L., and A. D. McFadden. The effect of competition on plants from large and small seeds of barley. Canad. J. Pl. Sci. 40: 623-629. 1960.

McFadden, A. D. Breeding for high yield. Proc. Canad. Soc. Agron., B, 7-12. 1958.

McFadden, A. D., and M. L. Kaufmann. Yield studies and yield components. Proc. Barley Genet. Conf. 1959.

McFadden, A. D., M. L. Kaufmann, R. C. Russel, and L. E. Tyner. Association between seed size and the incidence of loose smut in barley. Canad. J. Pl. Sci. 40: 611-615. 1960.

Newman, J. A. Reciprocal recurrent selection for body size in mice. Ph.D. thesis. University of Edinburgh. 1960.

Plank, R., and H. T. Fredeen. Litter size and post-weaning performance in swine. Proc. Canad. Soc. Anim. Prod., 48-49. 1961.

Walker, D. R., and C. F. Bentley. Sulphur fractions of legumes as indicators of sulphur deficiency. Canad. J. Soil. Sci. 41: 164-168. 1961.

Miscellaneous

Ashton, G. C., J. M. Bell, H. T. Fredeen, and P. Robinson. Suggestions for presentation of statistics in contributions to the *Canadian Journal of Animal Science*. Canad. J. Anim. Sci. 40: 156-157. 1960.

Bowman, G. H., H. T. Fredeen, and J. G. Stothart. The Lacombe breed. Can. Dep. Agric. Pub. 1095. 1957.

Bowman, G. H., H. T. Fredeen, and J. G. Stothart. Field testing of boars of the Lacombe breed. Can. Dep. Agric., Exp. Farm, Lacombe, Alta., processed circ. 1958.

Cairns R. R. Probing Solonetzic soils. Research for Farmers 6(3): 10-11. 1961.

Campbell, W. P., and H. A. Friesen. The control of ergot in cereal crops. Plant Dis. Reptr. 43: 1266-1267. 1959.

Elliott, C. R., E. C. Stacey, and W. J. Doran. Creeping red fescue. Can. Dep. Agric. Publ. 1122. 1961.

Fredeen, H. T. Construction and use of farrowing stalls. Can. Dep. Agric. Publ. 1102, 1958.

Fredeen, H. T. Development of the Lacombe hog. Research for Farmers 3(4): 15-16 1958.

Freeden, H. T. Animal science in the 20th century. Proc. Sask. agric. Coll. Grad. Assoc., 75-87. 1959.

Fredeen, H. T. Breeding plans for commercial swine production. Sask. Dep. Agric. processed pam. 1959.

Fredeen, H. T. Future trends in swine breeding research. Proc. Canad. Soc. Anim. Prod., N, 23-26. 1959.

Fredeen, H. T. Utilization of sports fisheries. Proc. Alta. Nat. Res. Conf., 139-143. 1960.

Fredeen, H. T. Record of performance test results for purebred Lacombes. Can. Dep. Agric., Exp. Farm, Lacombe, Alta., processed circ. 1961.

Fredeen, H. T. Swine production problems and policies. Proc. Canad. Soc. Anim. Prod., 3-8. 1961.

McFadden, A. D. Effect of seed size on yield and other characters in barley. Proc. Sask. Field Husb. Assoc., 26-33. 1960.

Newman, J. A. Long term animal improvement by ordinary selection method. Proc. Canad. Soc. Anim. Prod., 46-47. 1961.

The research staff at Lacombe contributed to the following publications (1958-1961) of the Alberta Department of Agriculture: *Alberta Farm Guide, Alberta Horticultural Guide, Chemical Control of Wild Oats, Fertilizer Recommendations for Alberta, Hay and Pasture Crops for Alberta, The Control of Toadflax in Alberta, Varieties of Grain for Alberta, Weed Control with Chemicals.*

Copies of this publication may be obtained from:

Information Division
CANADA DEPARTMENT OF AGRICULTURE
Ottawa, Ontario